LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: **Upper Medicine Lodge River**
Water Quality Impairment: Sulfate

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Medicine Lodge **Counties:** Barber, Comanche, Kiowa, & Pratt

HUC 8: 11060003

HUC 11 (HUC 14s)**:** **010** (010, 020, 030, 040, 050, and 080)

Drainage Area: 263 square miles

Main Stem Segment: WQLS: 8; starting at the confluence with Turkey Creek; Headwaters near Greensburg, in Kiowa County. **(Figure 1)**

Tributary Segments: WQLS: North Branch, Medicine Lodge River(24)
Thompson Creek (26)

Non-WQLS: Otter Creek *(25)*
Soldier Creek *(27)*
Unnamed Stream *(559)*

Designated Uses: Special Aquatic Life Support; Primary & Secondary Contact Recreation; Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segment and Thompson Creek

Expected Aquatic Life Support; Secondary Contact Recreation; Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for North Branch, Medicine Lodge River

1998 303d Listing: Table 1 - Predominant Point Source and Nonpoint Source Impacts

Impaired Use: Domestic Water Supply

Water Quality Standard: 250 mg/l for Domestic Water Supply (KAR 28-16-28e(c)(3)(A))

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the water

quality criteria listed in Table 1a of KAR 28-16-28e(d), at ambient flow, the existing water quality shall be maintained, and the newly established numeric criteria shall be the background concentration, as defined in KAR 28-16-28b(e). Background concentrations shall be established using the methods outlined in the "Kansas implementation procedures: surface water," dated June 1, 1999. (KAR 28-16-28e(b)(9)).

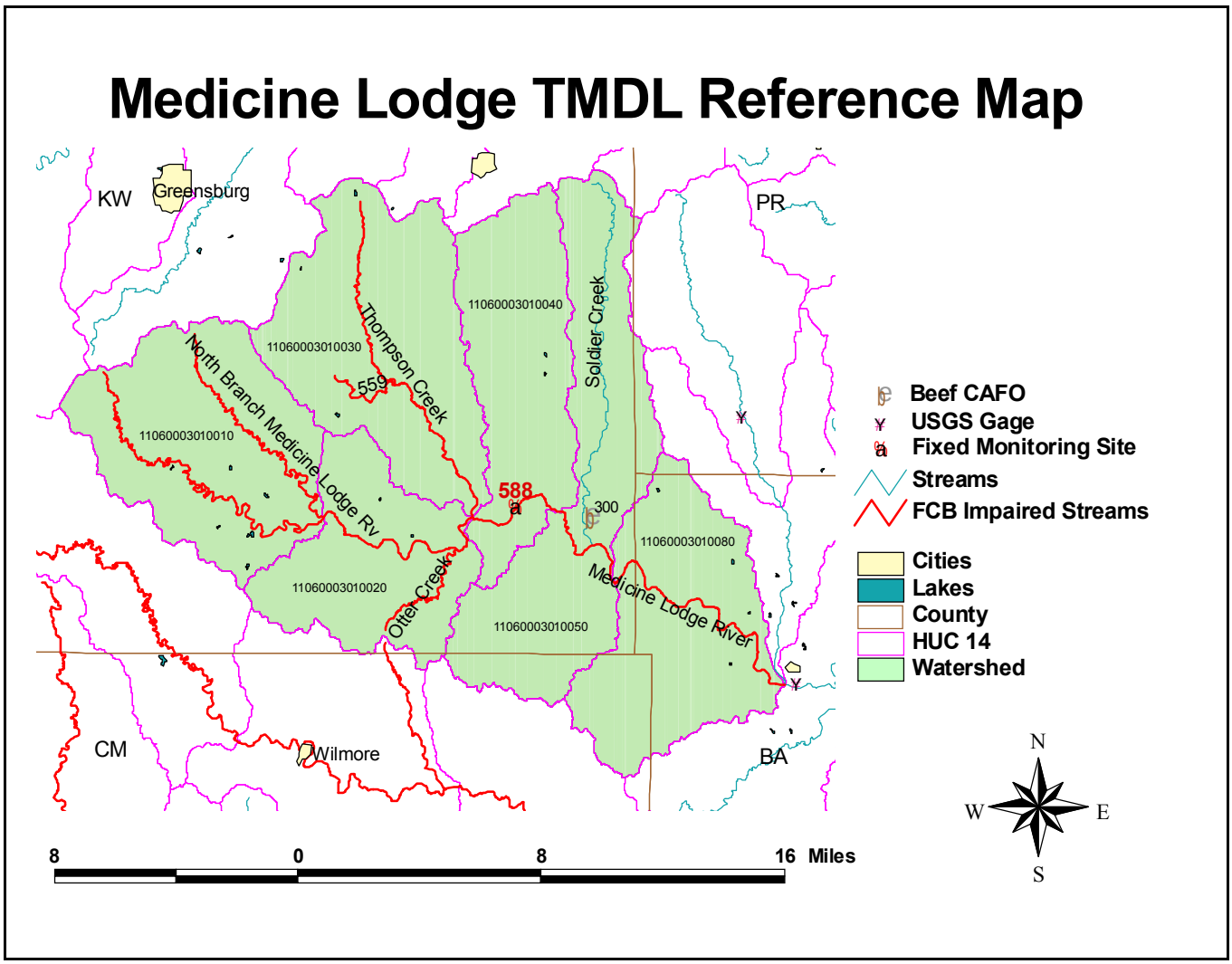

Figure 1

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303(d): Partially Supporting Domestic Water

Monitoring Sites: Station 588 near Belvidere

Period of Record Used: 1990 to 2000

Flow Record: Medicine Lodge at Sun City (07148600) flow was calculated by relating estimated flow duration data developed by USGS to actual flow duration data for the Medicine Lodge River near Kiowa (USGS Station 07149000; 1970-2000).

Long Term Flow Conditions: Median Flow = 24 cfs; 7Q10 = 1 cfs

Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Flow duration data were examined from the Medicine Lodge near Kiowa Gaging Station. High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. The load curve was established for the sulfate criterion by multiplying the flow values along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of tons of sulfate per day. The load curve represents the TMDL since any point along the curve represents water quality at the standard at that flow. Historic excursions from WQS are seen as plotted points above the load curve. Water quality standards are met for those points plotting below the applicable load duration curve.

Excursions were seen in all three seasons. Overall 17% of the samples were over the criteria. This would represent a baseline condition of partial support of the impaired designated use. These excursions occur at higher flows (exceeded less than 26% of the time). The flow duration curves for the Medicine Lodge River are flat, indicating uniform contributions of flow with each increment of higher flow, until the 25% exceedence level which rises substantially. This flow pattern may indicate a narrow band of contributing area under modest rainfall conditions. If this area were confined near the alluvial deposits, the resulting sulfate levels would be relatively low. At higher flows, with greater rainfall and runoff, the contributing areas extend upward within the watershed and likely encounter the Cretaceous formation outcrops with their high gypsum content. Sulfate levels would be expected to be greater at those higher flows. Overall, average sulfate concentrations were 173 mg/l, but concentrations taken at lower flow (below median flow) averaged 132 mg/l, while those at higher flows averaged 217 mg/l. The average of the ten samples which exceeded the standard was 303 mg/l.

PERCENT OF SAMPLES OVER WATER QUALITY STANDARDS BY FLOW

Station	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%.	Cum Freq.
Medicine Lodge River nr Belvedere	2	7	1	0	0	0	10/60=17%

Desired Endpoints of Water Quality (Implied Load Capacity) at Site 588 over 2005 - 2010: The ultimate endpoint for this TMDL will be to achieve the Kansas Water Quality Standards fully supporting Drinking Water Use. The current standard of 250 mg/L of sulfate was used to establish a load duration TMDL curve. Since the elevated sulfate levels are seen at higher flows, an alternative background criterion should be established at flows exceeded less than 25% of the time. Such a criterion might be 300 mg/l matching the average of the historic exceeding samples.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated sulfate levels. Achievement of the endpoints indicate loads are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

The primary cause of the sulfate impairment of the Medicine Lodge River in Kiowa County is natural dissolution of gypsum in the bedrock outcropping and underlying alluvial aquifer sediments in the watersheds. Any anthropogenic sulfate sources or hydrologic modifications increasing the sulfate concentration would be minor in comparison with the natural sulfate source in the watershed.

Background: Bedrock outcropping and underlying alluvial sediments of the watershed of the upper Medicine Lodge River in Kiowa County consists primarily of shales, siltstones, and sandstones of the Cretaceous System. Most of the Cretaceous bedrock that would affect the quality of runoff and ground-water discharge to the tributaries and mainstream of the river is the Lower Cretaceous Kiowa Shale and Cheyenne Sandstone. Gypsum (hydrated calcium sulfate), in the mineral form known as selenite, occurs in these formations. The selenite is present in different parts of the Cheyenne Sandstone and is common throughout the Kiowa Shale. Gypsum is a very soluble mineral and can lead to sulfate concentrations of nearly 2,000 mg/L when dissolved to saturation in ground water.

The sulfate concentration ranged from 97 to 748 mg/L in water of the Medicine Lodge River near Belvidere during 1996-1998 while the range in chloride conduct was 45-129 mg/L. The high sulfate/chloride ratio and the prevalence of gypsum in the bedrock fit natural dissolution as the predominant source of mineralized water in the river. The lack of sulfate under low flow conditions may reflect the isolation of the alluvial aquifer from outcrops of the Cretaceous formations.

Oil Fields: Oil-field brines have very low sulfate/chloride ratios in Kansas and could not be a significant source of sulfate based on the water chemistry of the Medicine Lodge River.

NPDES: There is one permitted facility discharging at times to a tributary of the main stem stream segment. This facility, a gypsum mine, holds the water from dewatering the mine in a lagoon system which only discharges under high flows. Its outfall is on a tributary which enters the Medicine Lodge River below the monitoring station.

Irrigation Return Flows: There is little irrigation in the watershed due to the prevalence of bedrock at or near the surface and the thin saturated thickness of unconsolidated sediments that are present. Therefore, there is very little effect on the sulfate content of the river water that could be attributed to irrigation. Most of the irrigation within the overall Medicine Lodge subbasin is located at the Pratt-Barber County line, associated with the southern extent of the Big Bend Prairie Aquifer in the headwaters of Elm Creek. Remaining irrigation is along the main stem of the river and some surface rights on headwater tributaries above Belvidere. In 1998, none of these rights pumped water.

Contributing Runoff: The watershed's average soil permeability is 2.5 inches/hour according to NRCS STATSGO data base. About 52% of the watershed produces runoff under relative low (1.5''/hr) rainfall conditions. Under very low (<1"/hr) potential conditions, this potential contributing area is almost halved (26%). Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from only 3% of this watershed, chiefly along the stream channels.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

The source assessment has ascertained that natural sulfate loading within the upper watershed generally is responsible for the occasional excursions seen at Belvedere.

Point Sources: A current Wasteload Allocation of zero is established by this TMDL because of the only point source in the watershed does not discharge except under high flow conditions. Should future point sources be proposed in the watershed and discharge into the impaired segments, the current wasteload allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers.

Non-Point Sources: The elevated sulfate concentrations appear to stem from drainage of Cretaceous geologic formations during high flows. The Load Allocation based on the existing standard will be 0.6-21.9 tons per day at flows of 1-36 cfs (greater than 25% exceedance). Using a background concentration for high flows exceeded less than 25% of the time would lead to loads of 26.2-262 tons per day at flows of 36-360 cfs.

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty of loading and the sulfate endpoint and will be ten percent of the applicable sulfate load, or 0.1-2.4 tons per day at 1-36 cfs and 3-30 tons per day at 36-360 cfs with an elevated background concentration as the applicable criterion.

State Water Plan Implementation Priority: Because it appears this watershed's sulfate load is predominately natural, this TMDL will be a Low Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Medicine Lodge subbasin (HUC 8: 11060003) with a priority ranking of 49 (Low Priority for restoration).

Priority HUC 11s: Because of the natural geologic contribution of this impairment, no priority subwatersheds or stream segments will be identified.

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of sulfate loading to river.
2. Establish alternative background criterion
3. Assess likelihood of river being used for domestic uses.

Implementation Programs Guidance

Non-Point Source Pollution Technical Assistance - KDHE

a. Evaluate any potential anthropogenic activities which might contribute sulfate to the river as part of an overall Watershed Restoration and Protection Strategy.

Water Quality Standards and Assessment - KDHE

a. Establish background levels of sulfate for the river and recommend an alternative water quality criterion for high flows.

Use Attainability Analysis - KDHE

a. Consult with Division of Water Resources on locating existing or future domestic points of diversion on the Medicine Lodge River for drinking water purposes.

NPDES - Industrial Programs - KDHE

a. Ensure the existing facility maintains condition and freeboard of its detention system to minimize overflows into the Medicine Lodge River.

Time Frame for Implementation: Continued permitted conditions after 2002. Development of a background level-based water quality standard should be accomplished with the 2002 water quality standards revision.

Targeted Participants: Existing permitted facility in upper watershed and KDHE.

Milestone for 2006: The year 2006 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, additional monitoring data from Medicine Lodge River will be reexamined to confirm the impaired status of the river and the suggested background loading. Should the case of impairment remain, source assessment and re-definition of the applicable sulfate criterion at high flows will ensue.

Delivery Agents: Depending upon confirmation of impairment and assessment of probable sources, the primary delivery agents for program participation will be the Kansas Department of Health and Environment.

Reasonable Assurances

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

4. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.

5. The *Kansas Water Plan* and the Lower Arkansas Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the

Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a Low Priority consideration and should not receive funding.

Effectiveness: Minimal control can be exerted on natural contributions to loading.

6. MONITORING

KDHE will continue to collect bimonthly samples at Station 588, including sulfate samples over each of the three defined seasons. Based on that sampling, the status of 303(d) listing will be evaluated in 2006 including application of a numeric criteria based on elevated background concentrations at high flows. Should impaired status remain, the desired endpoints under this TMDL will be refined and direct more intensive sampling will need to be conducted under specified seasonal flow conditions over the period 2006-2010.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Lower Arkansas River Basin were held March 9, 2000 and April 26-27, in Hutchinson, Wichita, Arkansas City and Medicine Lodge. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Lower Arkansas River Basin. A draft of this TMDL has been maintained on the website since June 1, 2000 and modifications to the original draft have been available to the public for viewing and review up to the date of submitting this TMDL to EPA.

Public Hearing: A Public Hearing on the original draft of these TMDLs of the Lower Arkansas River Basin was held in Wichita on June 1, 2000.

Basin Advisory Committee: The Lower Arkansas River Basin Advisory Committee met to discuss the TMDLs in the basin on September 27, and November 8, 1999; January 13 and March 9, 2000. The Committee recommended approval of the Basin Plan which set high priority TMDLs in the basin, thereby, delegating medium and low priority status to this and subsequent TMDLs for the basin. The Kansas Water Authority approved the Basin Plan on July 11, 2000.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:

Agriculture: January 12, February 2 and 29, 2000
Environmental: March 9, 2000
Conservation Districts: November 22, 1999
Industry: December 15, 1999, January 13, February 9 and 22, 2000
Local Environmental Protection Groups: September 30, November 2, December 16, 1999

Milestone Evaluation: In 2006, evaluation will be made as to the degree of impairment which has occurred within the drainage and current condition of Medicine Lodge River. Subsequent decisions will be made regarding implementation approach and follow up of additional implementation.

Consideration for 303(d) Delisting: Medicine Lodge River will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2001-2005. Therefore, the decision for delisting will come about in the preparation of the 2006 303(d) list. Should modifications be made to the applicable criterion during the ten-year implementation period, consideration for Delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2002 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in Kansas Water Plan implementation decisions under the State Water Planning Process after Fiscal Year 2005.

Approved July 27, 2001.